

WHAT IS CLAIMED IS:

1. A vibration wave driving apparatus comprising:

5 a vibration member having a shape line symmetrical with respect to two orthogonal planes; electro-mechanical energy conversion elements which can excite three different types of bending vibrations, in said vibration member, which displace in a direction of axis common to the two planes; and  
10 a driven member which is brought into contact with driving portions of said vibration member and driven by vibrations excited in said vibration member.

2. An apparatus according to claim 1, wherein  
15 said electro-mechanical energy conversion elements which can excite the three types of bending vibrations are arranged in the same plane.

3. An apparatus according to claim 1, wherein  
20 said vibration wave driving apparatus drives said driven member in an arbitrary direction in three dimensions by selecting and exciting two of the three types of bending vibrations.

25 4. An apparatus according to claim 1, wherein the driving portions of said vibration member protrude from said vibration member in a direction in

which the three types of bending vibrations displace.

5. An apparatus according to claim 1, wherein  
two of the three types of bending vibrations have the  
5 same vibration pattern and are  $90^\circ$  out of phase from  
each other in the same plane.

6. An apparatus according to claim 5, wherein  
one of the two types of bending vibrations has a node  
10 at which an antinode of the other bending vibration  
is located.

7. An apparatus according to claim 1, wherein  
the three types of bending vibrations have the same  
15 natural vibration frequency.

8. An apparatus according to claim 1, wherein  
said driven member has a curved surface that comes  
into contact with the driving portions of said  
20 vibration member.

9. A vibration wave driving apparatus  
comprising:

a vibration member which is made up of a plate  
25 member and projections protruding from a surface of  
the plate member and has a shape line symmetrical  
with respect to two orthogonal planes;

electro-mechanical energy conversion elements  
which are fixed to the plate member and excite three  
different types of bending vibrations that displace  
in a direction perpendicular to the plate member; and

5 a driven member which comes into contact with  
the projections of said vibration member,

wherein two of the three different types of  
bending vibrations are selected and synthesized to  
drive said vibration member in an arbitrary direction  
10 in three dimensions.

10. An apparatus according to claim 9, wherein  
said electro-mechanical energy conversion elements  
are arranged in the same plane.

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11. An apparatus according to claim 9, wherein  
two of the three types of bending vibrations have the  
same vibration pattern and are 90° out of phase from  
each other in the same plane.

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12. An apparatus according to claim 11, wherein  
one of the two types of bending vibrations has a node  
at which an antinode of the other bending vibration  
is located.

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13. An apparatus according to claim 11, wherein  
the two types of bending vibrations differ in

vibration pattern from the remaining type of bending vibrations.

14. An apparatus according to claim 11, wherein  
5 the two types of bending vibrations are excited by said same electro-mechanical energy conversion elements.

15. An apparatus according to claim 9, wherein  
10 the three types of bending vibrations have the same natural vibration frequency.

16. An apparatus according to claim 15, wherein  
a mass of said vibration member is increased at a  
15 position corresponding to an antinode of one of the three different types of bending vibrations which has a short wavelength.

17. An apparatus according to claim 9, wherein  
20 said driven member has a curved surface that comes into contact with the driving portions of said vibration member.

18. An apparatus according to claim 9, wherein  
25 said vibration member has a square outer shape.

19. An apparatus according to claim 18, wherein

the projections are arranged at substantially middle portions on the respective sides of the square.

20. An apparatus according to claim 18, wherein  
5 the projections are arranged at corner portions of the square.

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